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Market liquidity measurement and econometric models

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Objectives of our study:

- To analyze measures of market liquidity
- To model market liquidity using observable variables (volumes, prices, etc.)

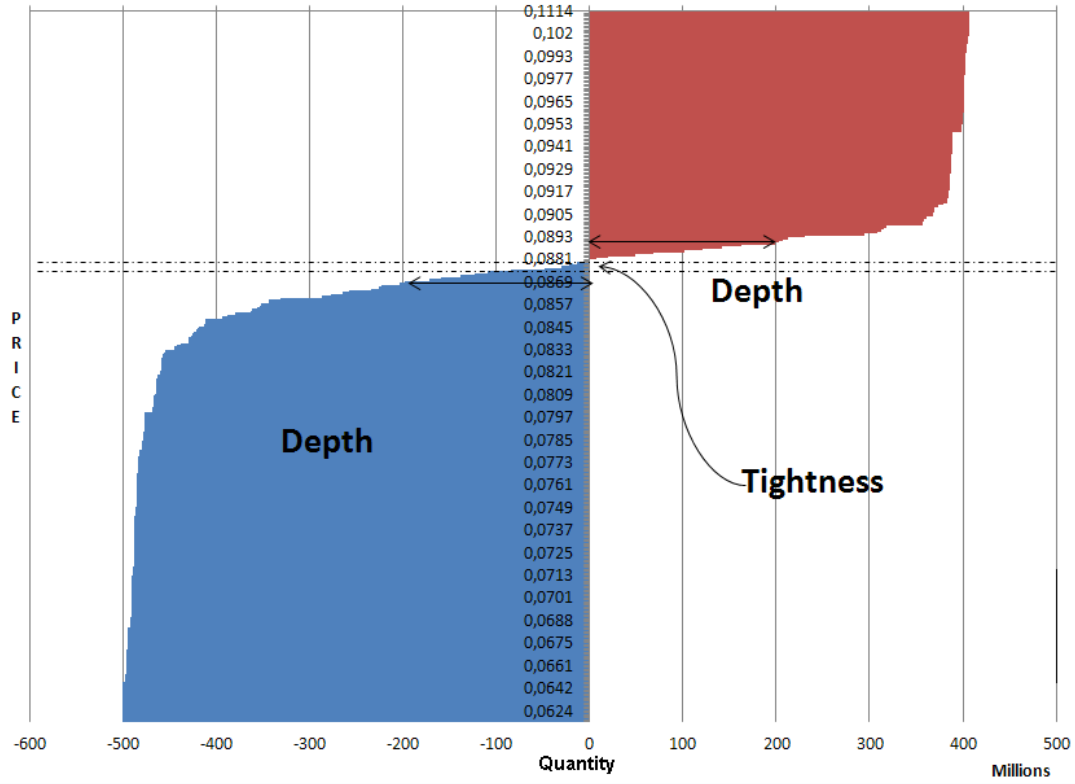
How to create order book correctly?

The creation of order book

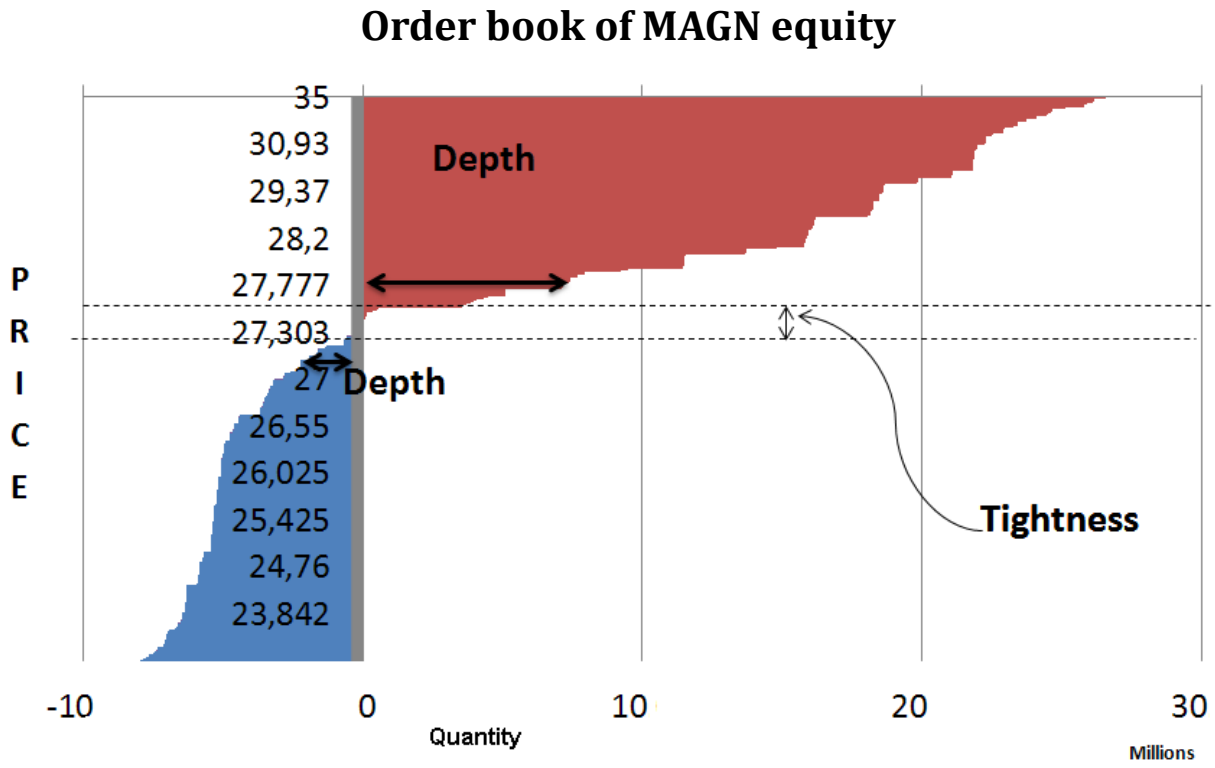
Code	Time	Price	Quantity	Endtime
370	01.09.2010 10:43	1,587	711400	01.09.2010 10:44
371	01.09.2010 10:43	1,587	2000	01.09.2010 12:12
372	01.09.2010 10:43	1,587	40000	01.09.2010 10:43
373	01.09.2010 10:43	1,589	2000	01.09.2010 18:44
374	01.09.2010 10:43	1,589	68900	01.09.2010 11:12
375	01.09.2010 10:44	1,587	15000	01.09.2010 17:26
376	01.09.2010 10:44	1,586	16500	01.09.2010 18:43
377	01.09.2010 10:44	1,586	10000	01.09.2010 18:43
378	01.09.2010 10:45	1,588	46700	01.09.2010 17:58
379	01.09.2010 10:45	1,588	6000	01.09.2010 17:01
380	01.09.2010 10:46	1,586	30000	01.09.2010 10:43

What are the main characteristics of market liquidity ?

Order book of VTBR equity



How to distinguish liquid and illiquid shares?



Approaches:

- **Transaction regression model**. *Berkowitz* (2000)
- **Models based on weighted spread data**. *Francois-Heude and van Wynendaele* (2001)
- **Volume-based price impact**. *Cosandey* (2001)

The transaction cost index (TCI)

$$TCI = \sum_{i=1}^{k} (p_i - p) n_i$$

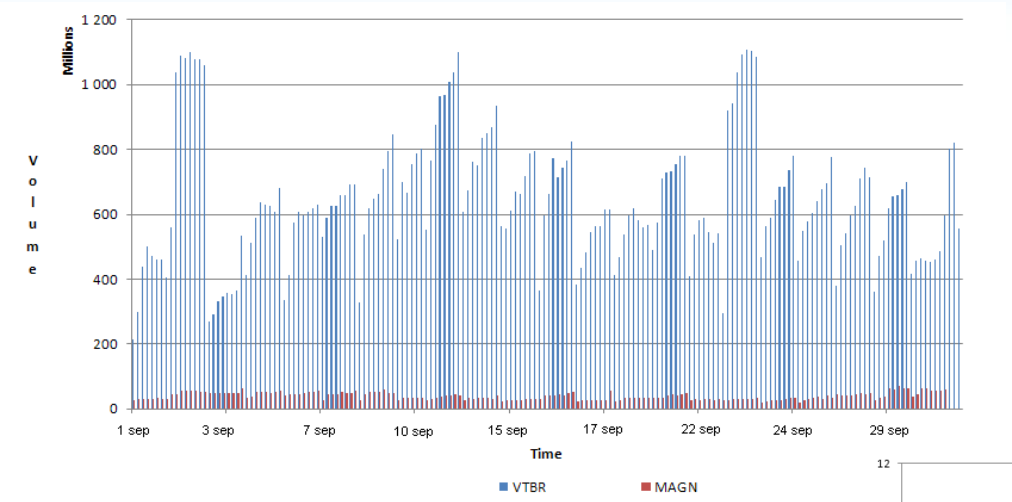
The relative transaction cost index (RTCI)

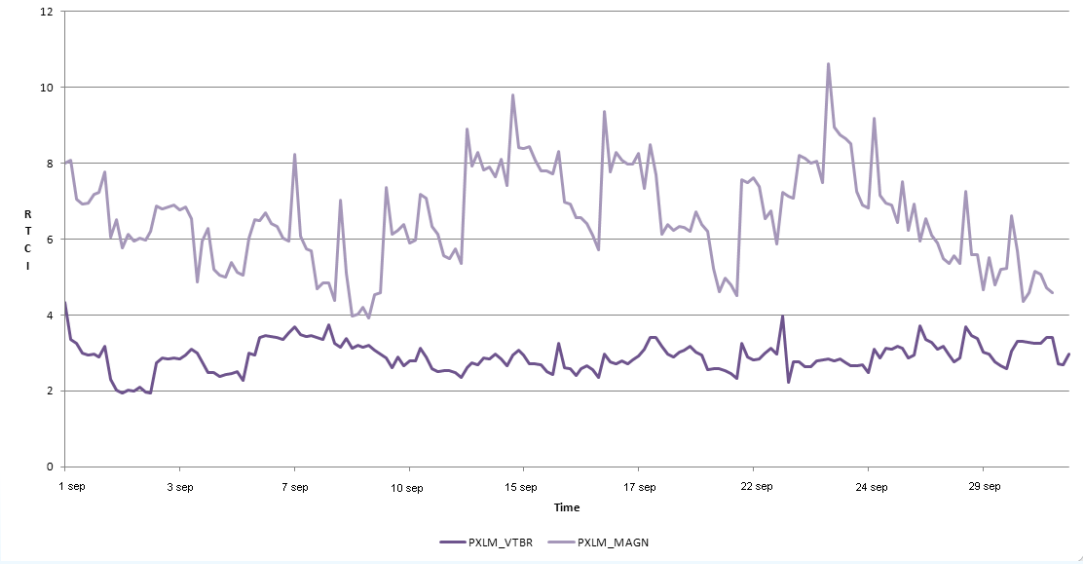
$$RTCI = \frac{\sum_{i=1}^{k} (p_i - p) n}{\sum_{i=1}^{k} p_i n_i}$$

p_i – price of an order; p – market price;

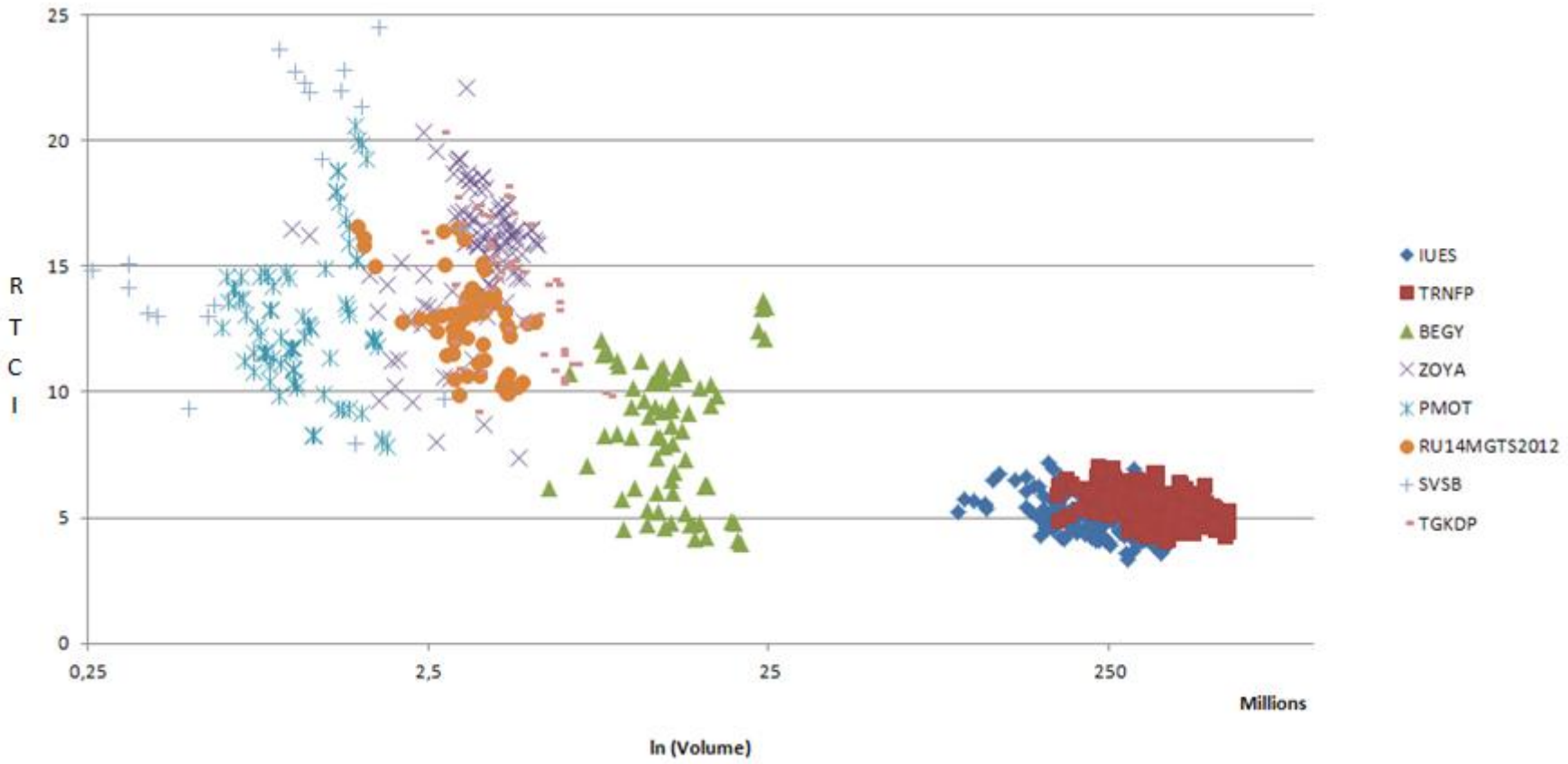
n_i – volume of an order; n – market volume.

What is a relationship between liquidity and volume?





RTCI and Volume



The preference costs index (PCI)

$$RTCI_{sell} = \frac{\sum_{i=1}^{k_{sell}} (p_i - p)n}{\sum_{i=1}^{k_{sell}} p_i n_i}$$

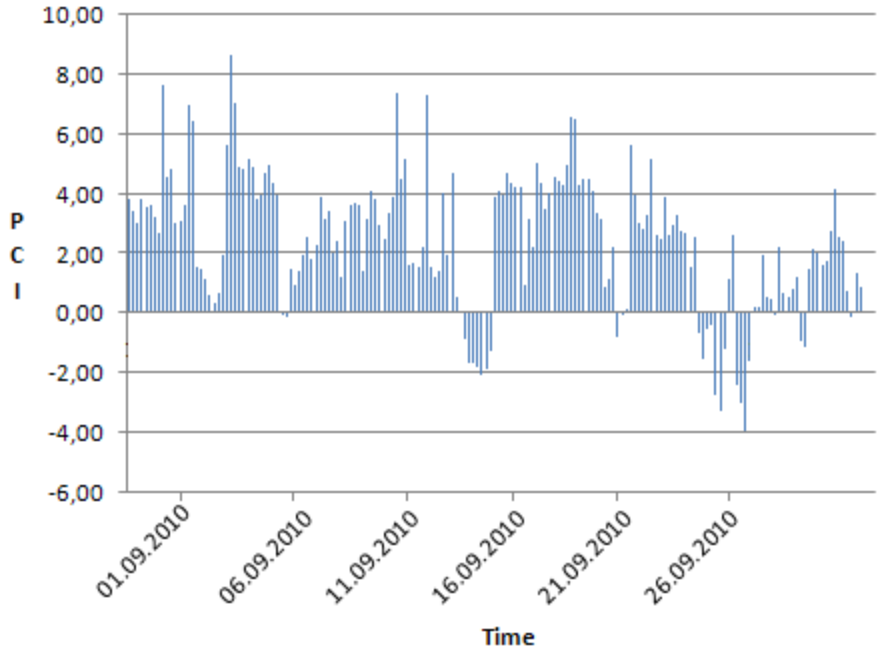
$$RTCI_{buy} = \frac{\sum_{i=1}^{k_{buy}} (p_i - p)n}{\sum_{i=1}^{k_{buy}} p_i n_i}$$

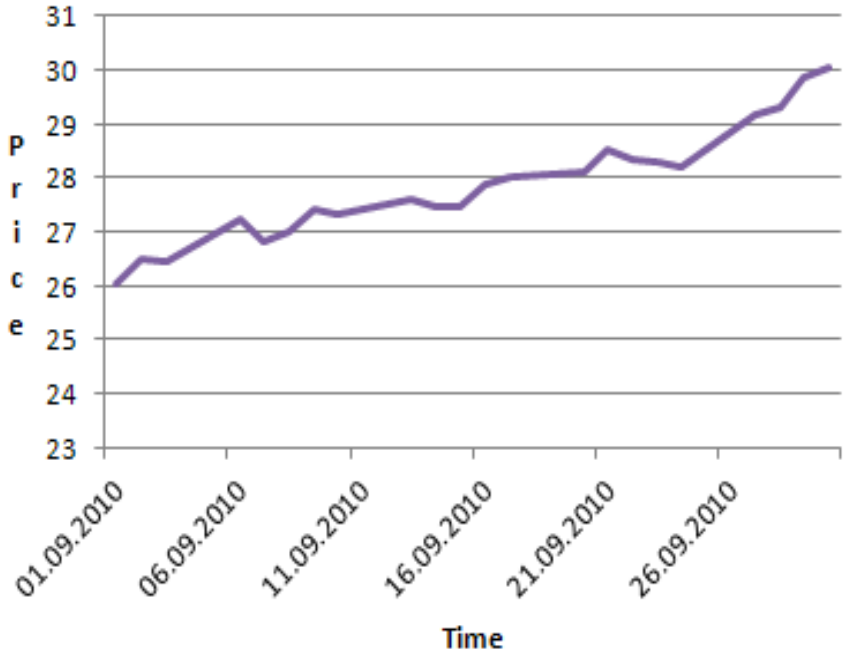
$$PCI = RTCI_{buy} - RTCI_{sell}$$

p_i – price of an order;
n_i – volume of an order;
p – market price;
n – market volume.

There is a positive correlation between PCI and dynamic of price…

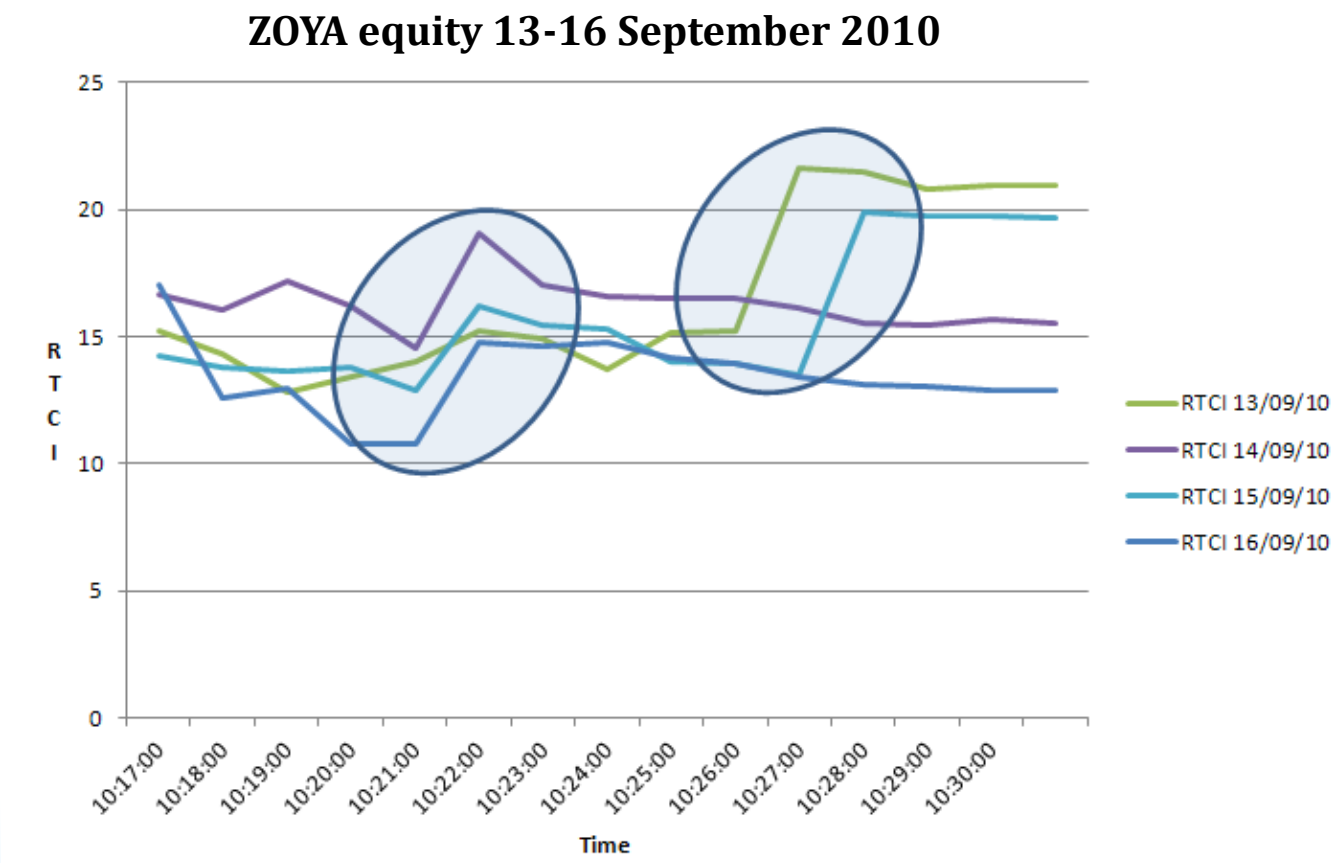
PCI of MAGN





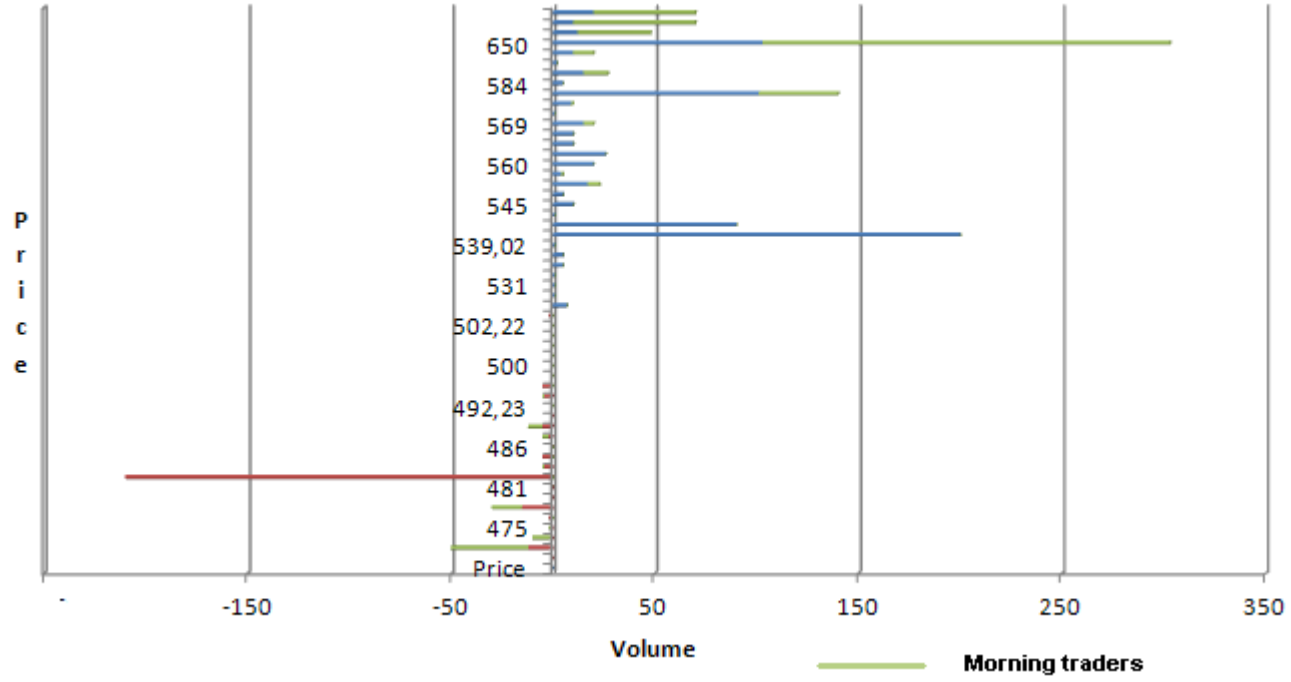
How do different agents affect liquidity?

Pre-Opening session liquidity

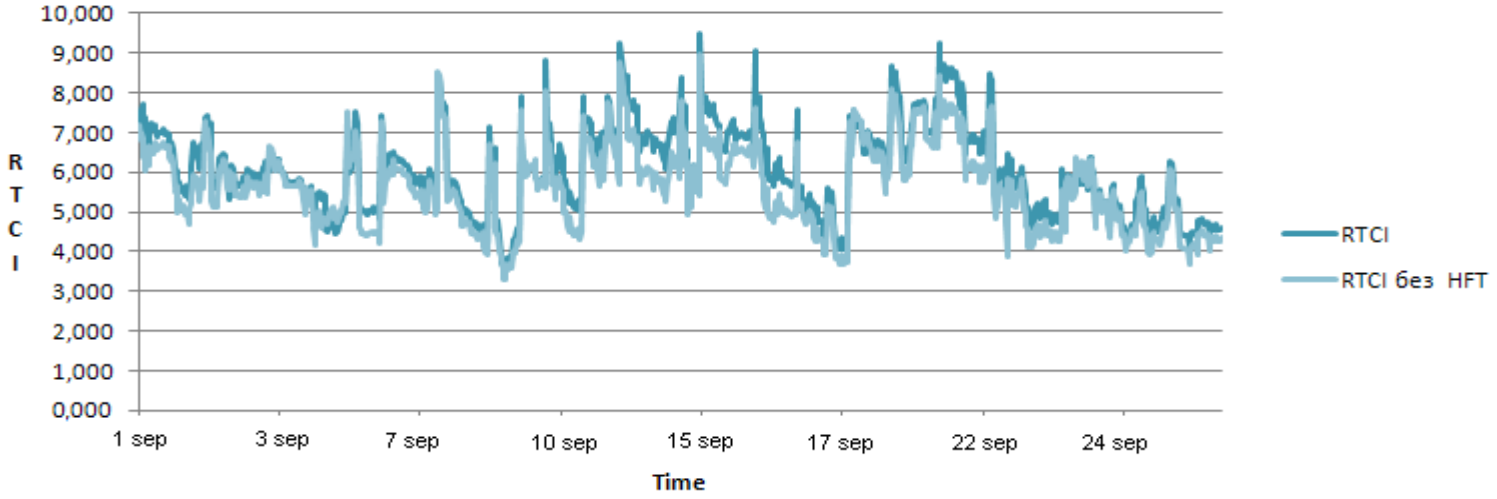


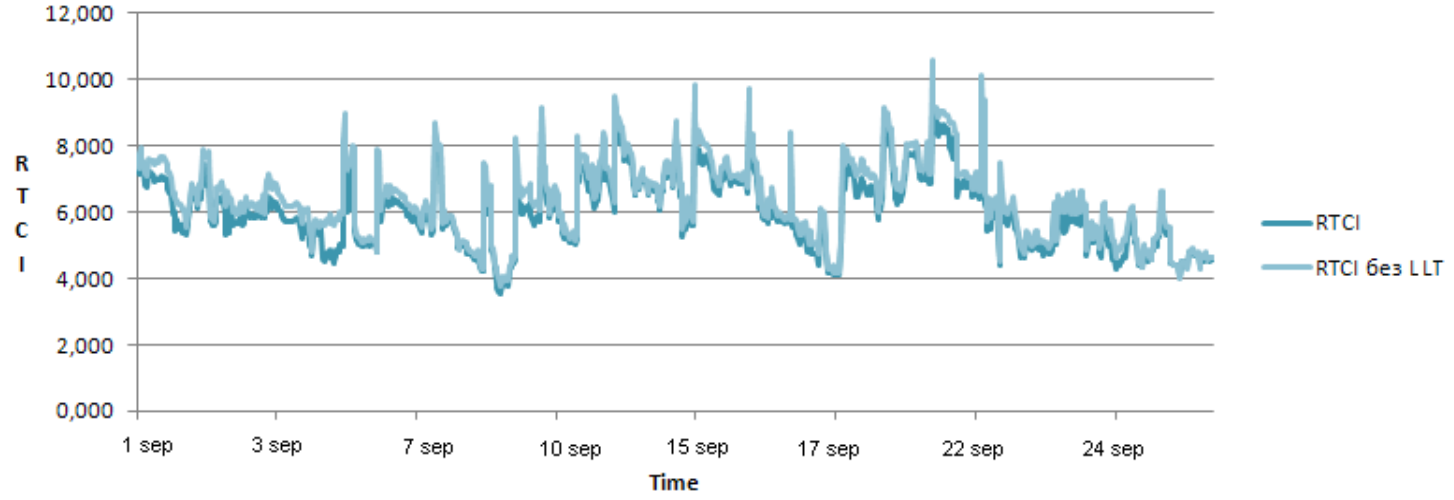
Morning traders

ZOYA 16 September 2010

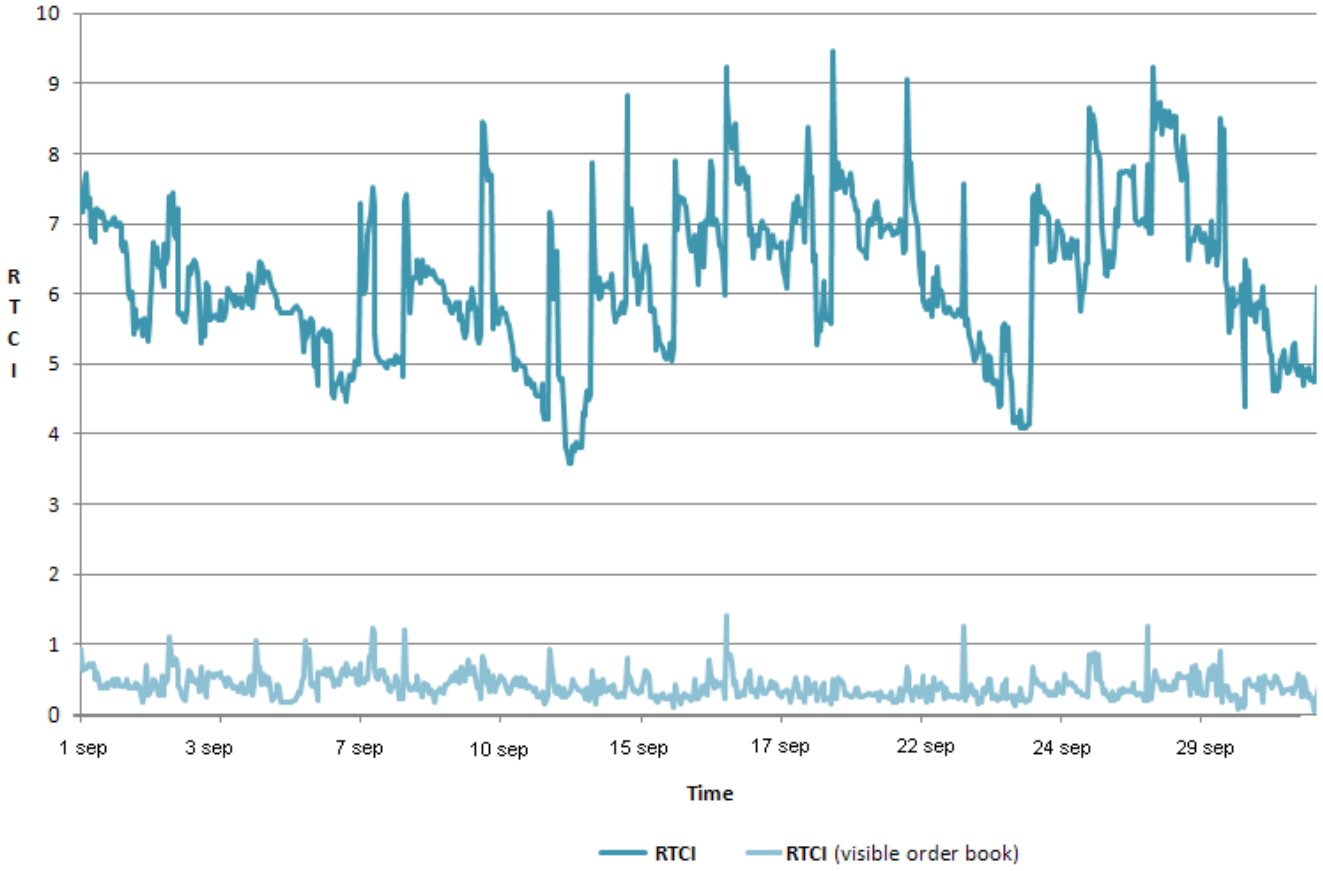


Liquidity Providers

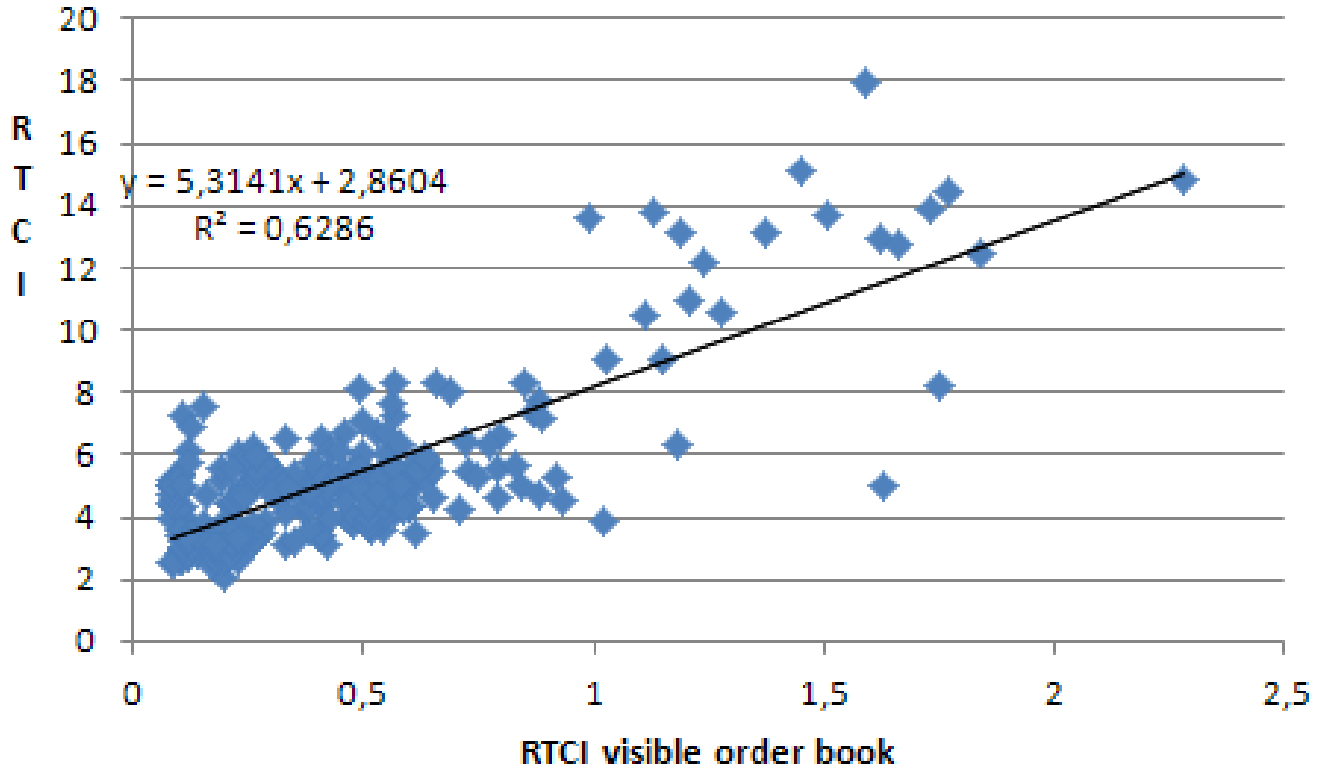




RTCI and visible order book



RTCI and visible order book



Market characteristics and quantitative liquidity measures

Probable regressors:

1. **Daily average percentage bid-ask spread** (Transaction Cost Measure**)**

$$S_i = \frac{P_{A_i} - P_{B_i}}{(P_{A_i} + P_{B_i})/2}$$

$$S_d = \frac{1}{N}\sum_{i=1}^{N} S_i$$

P_A – the lowest Ask-price at the end of *i*th hour of quotation;
P_B – the highest Bid-price at the end of *i*th hour of quotation;
S_i – percentage bid-ask spread at the end of *i*th hour of quotation;
S_d – daily average percentage bid-ask spread.

2. **Daily average turnover rate** (Volume-Based Measure)

$$TurnoverRateHour_j = \frac{\sum_{i=1}^{Q_j} p_{ij} q_{ij}}{S * p_j}$$

$$TurnoverRate = \frac{\sum_j TurnoverRateHour_j}{N}$$

Q_j – the number of trades during j hour;
p_{ij}, q_{ij} –prices and quantities of the i trade during j hour of quotation;
S –the outstanding stock of the asset;
p_j – the average price of the asset during j hour of quotation;
N – the number of hours during trade day;
$TurnoverRateHour_j$ – turnover rate during j hour of quotation;
$TurnoverRate$ – daily average turnover rate.

3. **Daily average Hui-Heubel Liquidity Ratio** (Volume-Based Measure)

$$L_{hh}\_hour_i = \frac{(p\min_i - p\max_i)/p\min_i}{TurnoverRateHour_i}$$

$$L_{hh} = \frac{\sum_{i=1}^{N} L_{hh}\_hour_i}{N}$$

$Pmax_i$ – the highest price at the end of *i* hour;

$Pmin_i$ – the lowest price at the end of *i* hour;

N – the number of hours during trade day;

$TurnoverRateHour_i$ – turnover rate of *i* hour;

$L_{hh}\_hour_i$ – Hui-Heubel Liquidity Ratio of *i* hour;

L_{hh} – Daily average Hui-Heubel Liquidity Ratio

4. **Daily average yield of an asset**

$$Yield\_hour_i = \frac{P_i - P_{i-1}}{P_{i-1}}$$

$$Yield = \frac{\sum_{i=1}^{N} Yield\_hour}{N}$$

P_i – the market price at the end of *i* hour;

N – the number of hours during trade day;

$YieldHour_i$ – yield of the asset during *i* hour;

Yield – Hui-Heubel Liquidity Ratio of *i* hour.

5. **Daily number of trades**

6. **Daily volume**

7. **Daily average volume of a trade**

8. **Daily average price of an asset**

$$\Pr ice\_hour_i = \frac{(P_{A_i} + P_{B_i})}{2}$$

$$\Pr ice = \frac{\sum_{i=1}^{N} \Pr ice\_hour_i}{N}$$

P_{Ai} – the lowest Ask-price at the end of *i*th hour of quotation;
P_{Bi} – the highest Bid-price at the end of *i*th hour of quotation;
N – the number of hours during trade day;
$Price\_hour_i$ – the price of the asset at the end of *i*th hour of quotation;
Price – daily average price of an asset.

Analyzed equities:

Liquid	Illiquid
JSC "Aeroflot" (common stock)	JSC "Zoloto Yakutii" (common stock)
JSC "AVTOVAZ" (preferred stock)	JSC "Sverdlovenergosbyt" (common stock)
JSC FGC UES (Federal Grid Company of Unified Energy System) (common stock)	JSC "Udmurtskaya energosbytovaya kompaniya" (common stock)
JSC Gazprom (common stock)	JSC "Permskie motory" (common stock)
OJSC "Mining and Metallurgical Company "NORILSK NICKEL" (common stock)	JSC "Kvadra" (WGC-4) (preferred stock)
JSC "RusHydro" (common stock)	JSC "MGTS" (preferred stock)
OJSC INTER RAO UES (common stock)	
OJSC Oil Company "LUKOIL"(common stock)	
OJSC The Magnitogorsk Iron and Steel Works (common stock)	
JSC "WGC-3" (common stock)	
JSC Gazprom Neft (common stock)	
JSC Transneft (common stock)	
OJSC VTB Bank OJSC (common stock)	

Liquid equities

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Dependent variable: **Relative Transaction Cost Indicator** *(panel data for 13 equities)*

Y = 4,93 - 13,58*X1 + 243,68*X2 + 50,31*X3

Coefficient	Value	Standard Error	t-Statistics	Probability
A0 (constant)	4,93	0,3509	14,0498	**0,0000**
X1 (AVERAGE VOLUME OF A TRADE[t])	-13,58	2,3518	-5,7730	**0,0000**
X2 (PERCENTAGE SPREAD[t])	243,68	70,2792	3,4674	**0,0006**
X3 (TURNOVER RATE[t])	50,31	3,0830	16,3179	**0,0000**

	Value
Quality Tests	
Coefficient of determination(R^2)	**0,67**
Adjusted coefficient of determination (adj R^2)	**0,66**
F-Statistics (F)	**189,04**
Probability F-Statistics (p-v)	**0,00**
Standard Error (SE)	1,43
Diagnostic Tests	
Durbin-Watson statistics (DW)	0,72
Analysis of residues	
Average balances	0,00

Liquid equities

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Dependent variable: **Relative Transaction Cost Indicator** *(panel data for 13 equities)*

Y = 3,56 - 4,35*X1 + 34,05*X2 + 3,31*X3

Coefficient	Value	Standard Error	t-Statistics	Probability
A0 (constant)	3,56	0,31	11,46	**0,0000**
X1 (AVERAGE VOLUME OF A TRADE[t])	-4,35	2,24	-1,94	**0,0531**
X2 (TURNOVER RATE[t])	34,05	3,37	10,11	**0,0000**
X3 (RTCI FOR THE BEST 20 ORDERS[t])	3,31	0,36	9,18	**0,0000**

	Value
Quality Tests	
Coefficient of determination(R^2)	**0,73**
Adjusted coefficient of determination (adj R^2)	**0,73**
F-Statistics (F)	**258,54**
Probability F-Statistics (p-v)	**0,00**
Standard Error (SE)	1,28
Diagnostic Tests	
Durbin-Watson statistics (DW)	0,74
Analysis of residues	
Average balances	0,00

Illiquid equities

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JSC SVERDLOVENERGOSBYT

Y = 3,55+ 46,68*X1 + 3 044,37*X2 + 42,71*X3

Coefficient	Value	Standard Error	t-Statistics	Probability
A0 (constant)	3,55	2,41	1,47	**0,1585**
X1 (PERCENTAGE SPREAD[t])	46,68	12,26	3,81	**0,0013**
X2 (TURNOVER RATE[t])	3 044,37	803,24	3,79	**0,0013**
X3 (VALUE OF THE BEST 20 ORDERS SVSB[t])	42,71	11,54	3,70	**0,0016**

	Value
Quality Tests	
Coefficient of determination(R^2)	**0,66**
Adjusted coefficient of determination (adj R^2)	**0,61**
F-Statistics (F)	**11,90**
Probability F-Statistics (p-v)	**0,00**
Standard Error (SE)	3,25
Diagnostic Tests	
Durbin-Watson statistics (DW)	1,31
Analysis of residues	
Average balances	0,00

Illiquid equities

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Y = 3,46 + 45,44*X1 + 3 017,09*X2 + 42,08*X3 + 0,02*X4				
Coefficient	**Value**	**Standard Error**	**t-Statistics**	**Probability**
A0 (constant)	3,46	2,55	1,36	**0,1921**
X1 (PERCENTAGE SPREAD SVSB[t])	45,44	15,23	2,98	**0,0083**
X2 (TURNOVER RATE SVSB[t])	3 017,09	846,86	3,56	**0,0024**
X3 (VALUE OF THE BEST 20 ORDERS SVSB[t])	42,08	12,64	3,33	**0,0040**
X4 (RTCI FOR THE BEST 20 ORDERS SVSB[t])	0,02	0,17	0,15	**0,8855**

	Value
Quality Tests	
Coefficient of determination(R^2)	**0,67**
Adjusted coefficient of determination (adj R^2)	**0,59**
F-Statistics (F)	**8,44**
Probability F-Statistics (p-v)	**0,00**
Standard Error (SE)	3,34
Diagnostic Tests	
Durbin-Watson statistics (DW)	1,30
Analysis of residues	
Average balances	0,00

Thank you!